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INTERVENTIONAL RADIOLOGY

ORIGINAL ARTICLE

Safety of ultrasound-guided distal radial artery access for abdominopelvic transarterial interventions: a prospective study

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PURPOSE
We aimed to evaluate ultrasound-guided distal radial artery (DRA) access to perform abdominopelvic endovascular procedures.

METHODS
A prospective, observational study was carried out in a single center between December 2017 and February 2019. Forty-two abdominopelvic endovascular procedures were performed by the same operator in 37 patients with DRA access using a 5 F sheath. Most patients were male (67.6%) with a mean age of 62.0±11.4 years (age range, 27.6–82.8 years). Patient characteristics, including Barbeau's test classification, radial and ulnar sizes and technical success, were evaluated. Patients with a DRA smaller than 1.7 mm could not be safely punctured and were not included.

RESULTS
Procedures included chemoembolization of hepatocellular carcinoma in 35 cases (83.3%), embolization of hepatic metastasis in neuroendocrine tumors in 4 cases (9.5%) and other embolization procedures in 3 cases (7.1%). The mean diameters of the DRA, proximal radial artery and proximal ulnar artery were 2.31, 2.63, and 2.09 mm, respectively. Out of 42 DRA puncture attempts, 97.6% (41/42) were successfully performed. There were no postoperative complications related to the access site, such as pain, palsy, paresthesia, occlusion, finger ischemia, bleeding, hematoma, and pseudoaneurysm. Transient forearm discomfort was reported in 7.1% of patients (3/42); one occurrence was associated with kinking rectification, and two occurrences were attributed to small arteries and/or vasospasm.

CONCLUSION
Ultrasound-guided DRA access seems to be feasible and safe to perform in abdominopelvic endovascular procedures in patients with a DRA considered amenable to be safely punctured, with high technical success rates.

The transradial approach is a well-known safe and useful alternative approach to transfemoral access for coronary, neurointerventional and abdominopelvic interventional procedures (1–3). Compared to femoral artery access, radial access is associated with lower morbidity and mortality rates (4), fewer complications at the vascular access site, earlier ambulation, greater postprocedural comfort for the patient and better cost-effectiveness (1). In 2017, Kiemeneij (5) reported that distal radial access in the anatomical snuffbox had theoretically fewer hemorrhagic complications than did conventional radial access. This access improves operator and patient comfort during the procedure, especially when using the left radial approach. In addition, no forced external rotation of the forearm is needed during procedures.

The aim of this study was to reproduce and detail this technique and to evaluate the safety and feasibility of the ultrasound-guided distal radial artery (DRA) approach to perform abdominopelvic transarterial interventional procedures.

Methods

Patients

Ethical approval from the hospital committee was obtained (3.681.985) and informed consent was a prerequisite for enrolling each subject.

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This prospective, single-arm, observational study was carried out between December 2017 and February 2019. A total of 42 abdominopelvic transarterial interventional procedures, in which the use of the DRA approach was intended, were performed in 37 patients. All procedures were performed by one interventional radiologist with 8 years of experience (LMM).

Patients with a DRA smaller than 1.7 mm were not included in the study due to size incompatibility to receive a 5 F sheath and due to a higher risk of local complication.

DRA access

The DRA is typically palpable at the intersection of the thumb and first finger over the boney structures of the snuffbox. The left DRA was more frequently chosen for abdominal interventions involving the liver, and the right DRA was chosen for pelvic interventions or for abdominal interventions involving the kidneys or spleen and for those performed under sedation or general anesthesia.

Preliminary ultrasound evaluation of the radial artery was performed to ensure adequate vessel size for puncture at both the DRA and proximal radial artery (PRA) puncture sites. In patients with DRA diameters of less than 1.7 mm or radial artery occlusion (RAO), a puncture was not attempted, and the patient was not included in the study.

When the access was performed in the left arm, a cushion was placed under the left upper arm, the forearm was kept across the abdomen, and the hand was placed in internal rotation above the right groin. When the access was performed in the right arm, the arm was placed across the torso, with the wrist in neutral position and with a discrete internal rotation relative to the anatomic position (Fig. 1). A Barbeau test (6) was performed before arterial puncture. The DRA was punctured independent of Barbeau test classification.

All attempts were performed under local anesthesia. Sedation was used as needed according to the procedure or patient clinical status. After subcutaneous injection of approximately 2.0 mL of 2% lidocaine, the radial artery was punctured at the dorsum of the hand, distal to the snuffbox (Fig. 2), under ultrasound guidance using a 21 G, 4.0 cm needle and single-wall technique. When pulsatile arterial blood return was visually confirmed, a 0.018-inch wire was advanced into the radial artery. When the vessel was properly accessed, the needle was removed, and a 5 F, 11 cm sheath was placed. A small skin incision was sometimes necessary before introducing the introducer-dilator kit to prevent damage to the tip of the introducer and sheath (Fig. 3). After sheath placement, 200 mg of nitroglycerin was subsequently administered through the sheath, followed by a saline flush. Systemic heparinization was intravenously induced with 5000 IU of heparin. The sheath was always kept under a continuous flush of 1 mL/min of 100 mg of papaverine diluted in 1000 mL of saline.

All procedures were performed using a 5 F 125 cm long angiographic catheter (Performa, Merit Medical Systems). The distal catheter shape was chosen according to the vessel anatomy depending on the type of procedure and included a straight pigtail, Berenstein, Ultimate 1, Cobra 2. The microcatheter was always 150 cm in length (Maestro, Merit Medical Systems; Excelsior 1018, Stryker Neurovascular), and the 0.014-inch guidewire was at least 180 cm in length (True Form, Merit Medical Systems; Transend, Stryker Neurovascular).

After the procedure, all wires and catheters were removed. Manual compression was applied at the punctured site distal to the snuffbox for 10 to 15 minutes. A non-compressive dressing was then applied at the punctured site. DRA compression devices were not commercially available at the time of the study and thus could not be used. Clinical evaluation of the access site was performed, and the radial pulse both distal to the snuffbox and in the wrist was evaluated for all patients approximately at two hours and at 30 days after the procedure.

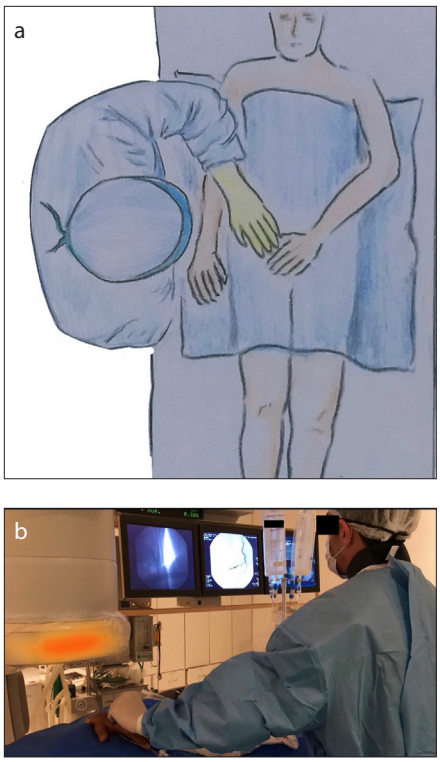

Figure 1. a, b. Operator on the right side of the patient performing left distal radial access.

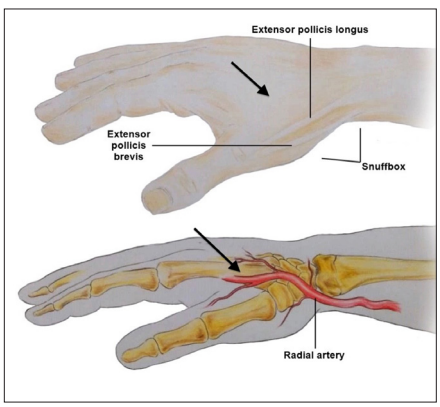

Figure 2. Catheterization site of distal radial artery. The *black arrow* shows the segment that was punctured.

Outcome assessment

Technical success was defined when the DRA approach was successfully achieved among patients with a DRA considered amenable to receiving a 5 F sheath, and the entire procedure could be successfully completed.

Clinical evaluations were conducted 2 hours and 30 days after the procedure. Patients were evaluated for puncture-related complications, such as pain, palsy, paresthesia, finger ischemia, bleeding, hematoma, and pseudoaneurysm, and for the presence of pulse in the DRA and PRA puncture sites.

Main points

- Distal radial access (DRA) improves operator and patient comfort during the procedure, especially when using the left radial approach, and is theoretically safer than radial access in the common wrist approach.
- We did not encounter postoperative complications related to the access site, such as pain, palsy, paresthesia, finger ischemia, bleeding, hematoma, and pseudoaneurysm.
- Based on our data, DRA access under ultrasound guidance seems to be safe and feasible, with reproducible and high technical success rates and low complication incidences.

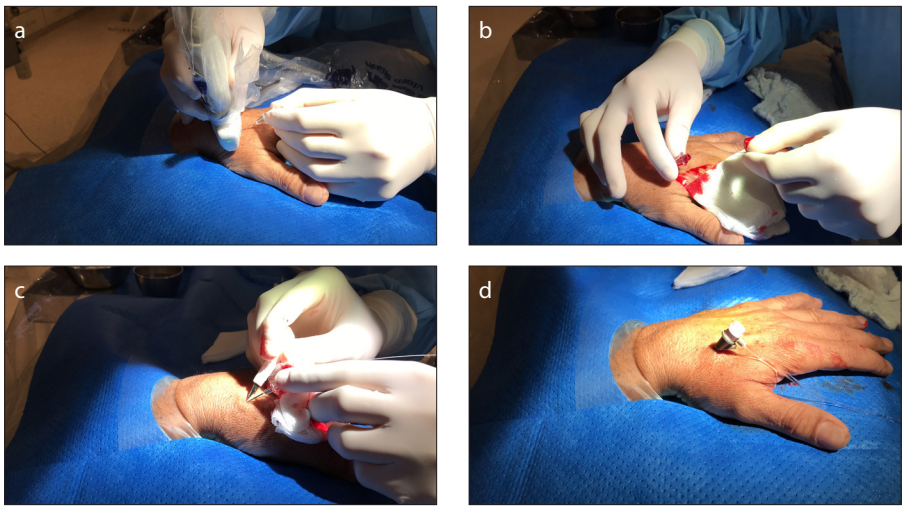

Figure 3. a–d. Left radial artery puncture at the dorsum of the hand, distal to the snuffbox **(a)**, under ultrasound guidance using a 21 G, 4.0 cm needle and single-wall technique. In panel **(b)**, a 0.018-inch wire is advanced into the radial artery. In panel **(c)**, skin incision is performed before introducing the introducer-dilator kit. Panel **(d)** shows sheath placement into the left distal radial artery.

Table 1. Patient characteristics

Characteristics	n=42
Age (years), mean±SD (range)*	62.0±11.4 (27.6–82.8)
Male, n (%)*	26 (67.6)
Barbeau A, n (%)	7 (16.7)
Barbeau B, n (%)	30 (71.4)
Barbeau C, n (%)	4 (9.5)
Barbeau D, n (%)	1 (2.4)
Technical success, n (%)	41 (97.6)

SD, standard deviation.
*Age and sex data represent total patients (n=37) and not total procedures.

Table 2. Radial and ulnar sizes and ratio

Measurement and ratio of DRA and PRA	Mean±SD (range)
DRA size (mm)	2.31±0.44 (1.70–3.20)
PRA size (mm)	2.63±0.40 (1.90–3.70)
Proximal ulnar artery size (mm)	2.09±0.50 (1.30–3.20)
PRA/DRA discrepancy (mm)	0.32±0.29 (0.00–1.10)
DRA/PRA ratio	0.88±0.10 (0.61–1.00)

DRA, distal radial artery; PRA, proximal radial artery; SD, standard deviation.

Results

Thirty-seven patients, most male (67.6%) with a mean (±SD) age of 62.0±1.4 years (range, 27.6–82.8 years), underwent 42 abdominopelvic transarterial interventional procedures, in which the use of DRA access was intended. Indications for the procedures included hepatic chemoembolization in 35 cases (83.3%), hepatic embolization in 4 cases (9.5%), uterine artery embolization for fibroids in one case (2.4%), spleen embolization in one case (2.4%) and renal tumor embolization in one case (2.5%) (Table 1).

The mean (±SD) diameter of the DRA was 2.31±0.44 mm (range, 1.7–3.2 mm); the mean diameter of the PRA was 2.63±0.40 mm (range, 1.9–3.7 mm); the mean diameter of the wrist ulnar artery was 2.09±0.5.0 mm (range, 1.3–3.2 mm) (Table 2).

A technical success rate of 97.6% was obtained (41/42). In the unsuccessful case, the guidewire did not progress through the vessel due to vasospasm. In this case, ipsilateral PRA access was successfully obtained, with no need for conversion to transfemoral artery approach.

Barbeau type A was observed in 7 cases (16.7%), type B in 30 cases (71.4%), type C in 4 cases (9.5%) and type D in just one case (2.4%). In all Barbeau types, the puncture and procedure were successfully performed without complications.

The left radial artery was selected in 88.1% of the cases (37/42). One pelvic, one renal, and one splenic procedure were performed through the right radial artery as originally intended, and two liver procedures were performed under sedation. The right radial artery was chosen for the convenience of the operator.

Among all patients (both DRA and PRA puncture sites), 7.1% (3/42) described forearm pain during the procedure. One patient reported mild discomfort, one patient reported moderate discomfort, and one patient reported severe discomfort. Discomfort disappeared immediately after the catheter and sheath were removed in all cases. The case of severe discomfort was attributed to a proximal radial kinking rectification, and the other cases were attributed to small vessel diameter and vasospasm (DRA and PRA mean diameters were 1.75 and 2.50 mm, respectively).

Four patients successfully underwent more than one procedure using the same DRA, without access site complications.

The clinical evaluation 2 hours postprocedure and at 30-day follow-up revealed the presence of pulse in both the DRA and PRA in 100% of patients. There were no postoperative complications related to the access site, such as pain, palsy, paresthesia, finger ischemia, bleeding, hematoma, and pseudoaneurysm.

Discussion

The transradial approach has been studied in past decades, and many advantages of this approach over the transfemoral approach have been described, including the following: fast recovery, fewer severe hemorrhagic events, ease of hemostasis and patient preference (3, 4). Since its first description in coronary intervention (5), the DRA approach has been advocated for the following two main reasons: to reduce the risk of RAO at the forearm and to improve operator and patient comfort, especially when using the left radial approach (7).

The DRA is the segment of the radial artery located after the emergence of the superficial palmar arch branch, in the volar face of the hand, in the anatomical snuffbox, and distal to the extensor pollicis longus tendon. The DRA is located approximately 5 to 7 cm from the conventional radial puncture site in the palmar face of the wrist. This distance is of great significance since it might impact the selection of the catheter and microcatheter length, depending on the proposed interventional procedure, and might contraindicate the use of this approach, depending on the patient's height.

Another characteristic that may limit the DRA as an approach option for diagnostic and mainly interventional procedures is its caliper. The DRA tends to be significantly thinner than the PRA in approximately 10% to 15% of people, and the difference can

reach 1.9 mm in some patients, limiting the safe positioning of the sheath (8). Most vascular complications related to the access site are associated with incompatibility between the artery and sheath diameter. Naito et al. (9) indicated safe cannulation when the artery/sheath ratio >1.0. Performing interventions through the DRA approach without measuring the diameter of the artery might be associated with a high risk of artery injury. In our study, patients presenting DRA diameters smaller than 1.7 mm were consistently excluded from puncture attempts, which may have decreased the complications due to vascular injury. DRA ultrasonographic evaluation and puncture guidance are associated with higher puncture success rates and lower complication rates (10–12), and its use should be encouraged.

All procedures were performed using a 5 F 11 cm sheath because the catheters available during the study were only 5 F.

Kiemeneij (5) described a technical success rate of 89.6% for snuffbox left radial access to perform coronary interventions in 70 selected patients. Pua et al. (10) used snuffbox radial access for visceral interventions and reported a technical success of 100% in 50 cases, all of which were ultrasound-guided. Nardai et al. (13) also described a technical success of 100% in 58 cases of carotid intervention performed with the DRA approach and the use of ultrasound to guide arterial puncture. A technical success rate of 98.2% was reported by van Dam et al. (14) in 56 patients with 82 punctures for noncoronary endovascular procedures. The technical success of the DRA approach for coronary percutaneous interventions varied from 70% to 100%, and most reports did not use ultrasound guidance (12, 15–19). Posham et al. (3) described technical success in 1485 of 1512 cases (98.2%) in transradial access for noncoronary interventions through conventional PRA access. Our technical success rate (97.6%) was in accordance with the DRA access reported in the literature.

One patient was classified as type D in Barbeau's test and did not experience pain during the procedure or postprocedural complications. Barbeau type D is a formal contraindication to PRA puncture, but due to anatomical reasons, DRA access can be safely performed in these patients due to the proximal branch to superficial palmar arch that keep the fingers normally perfused even if the DRA segment occludes in the future.

In the present article, one patient presented vasospasm at the puncture site that blocked the progression of the guidewire through the artery. In this case, ipsilateral PRA access was successfully achieved, with no need for conversion to the transfemoral approach. Kiemeneij (5) successfully converted all failed left DRA access attempts to a conventional right or left PRA approach. Van Dam et al. (14) converted all failed cases to a transfemoral approach. As Pua et al. (10) and Nardai et al. (13) reported no technical failure, no conversion to conventional PRA or a transfemoral approach was needed. In all procedures, we did not face any difficulties in catheter navigation or positioning, and the treatments proposed were successfully performed in each case.

In this study, the mean (±SD) diameter of both DRA and PRA were comparable to the available literature (DRA, 2.31±0.44 mm; PRA, 2.63±0.40 mm). Naito et al. (9), studying the diameter of the DRA at the anatomical snuffbox using ultrasound in a Japanese population, found a DRA mean diameter of 2.02±0.44 mm and 2.57±0.58 mm in conventional access points of the radial artery. Yongcheol et al. (20) reported that the mean diameter of the DRA was 2.65±0.46 mm in South Korean men and 2.40±0.53 mm in South Korean women. Three patients (7.1%) described forearm discomfort during the procedure; the discomfort of one of the patients was due to kinking rectification, and the discomfort in two of the patients probably due to small radial artery diameter and vasospasm. In all patients, discomfort resolved after catheter and sheath removal. Dharma et al. (21) studied postprocedural arm pain in patients who underwent a transradial approach to coronary interventional procedures and found some factors related to a higher incidence of pain, including hemostasis compression higher than 4 hours, presence of RAO at Doppler evaluation, multiple puncture attempts and a radial artery diameter less than 2.8 mm. Although the patients in our study did not report postprocedural forearm pain, the findings described by Dharma et al. (21) that most patients who presented with discomfort in the forearm had small DRA and PRA diameters indicate that this symptom may be associated with vessel caliber and secondary vasospasm.

No major complications were observed in this study. All patients presented normal DRA and PRA pulse at two hours postprocedure and at 30 days, denoting no cases of clinical RAO. Most studies (5, 10, 12–16, 19) described low or no events of RAO with the DRA approach, suggesting less access to the radial artery in the DRA approach than in the conventional PRA approach. In contrast, Koutouzis et al. (18) found high rates of RAO of both DRA and PRA access. Sinha et al. (22) studied RAO after transradial diagnostic and therapeutic coronary interventions in 1945 patients and showed 17.4%, 13.6% and 5.1% RAO with Doppler study at 1 day, 1 month and 6 months, respectively; moreover, in addition to the occlusion, all patients were asymptomatic, and the radial pulse was still palpable in some patients (5.9%, 5.8% and 3.4% of all patients evaluated had loss of pulse, respectively). As the evaluation of patency was performed only with clinical evaluation, RAO might be underdiagnosed in our study. Postprocedure follow-up Doppler evaluation is encouraged in future studies to diagnose eventual subclinical RAO.

This study has some limitations. Procedure time, radiation dose and fluoroscopy time were not evaluated since the objective of the study was focused on the access site for abdominopelvic procedures. As different types of interventional procedures were included, these data would exceed the scope of the study and would not yield relevant information. Future studies should include information on radiation and procedure time and a control group that undergoes the same range of procedures through transfemoral and/or PRA approaches, to obtain sufficient data for comparison. Unfortunately, no data was taken regarding puncture time or attempts. This information could allow comparison to non-ultrasound-guided puncture or puncture of sites other than distal radial. Future research on this field should include this data.

In conclusion, our study suggests that DRA access under ultrasound guidance for abdominopelvic interventional procedures is safe and feasible, with reproducible and high technical success rates and low complication incidences, in DRAs considered amenable to be safely punctured.

Conflict of interest disclosure

The authors declared no conflicts of interest.

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